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Field Experiments and the Interpretation of Their Results.

By
G. E. Coombs and J. Grantham.

The experimenter in agricultural science is placed at a great disadvantage compared with the worker in the field of pure science, in that he is called upon to work with material of widely varying nature, and must use methods which are at best only conventional: for these reasons his experiments must be most carefully planned and his results most critically analysed before they may be used for generalizations.

Until comparatively recently much of the work which has passed as agricultural experimentation has belied the term; much accurately planned work has been so carelessly carried out in matter of record-making as to put it beyond the pale, but the error which has been most consistently noticeable is, that in the interpretation of results, generalizations have been made from the results of single experiments.

The Journal of Agricultural Science Vol. III. Part IV. contains a paper by Wood and Stratton on this subject.

"Everyone who has carried out experiments in the field or farmyard must be well aware that the result of a single experiment is very often entirely misleading. Yet it is still common practice to publish single results and to base practical advice upon them."

This was written five years ago in England and it is not perhaps too much to say that it truthfully describes the present condition of affairs in this country, at any rate in so far as accessible published results go. We have been carrying out field experiments on rubber, work on rice is in progress, and work on coconuts is awaiting us, and since the matter may be new to most experimenters,

it has been thought worth while to indicate the general method which may be employed to obtain reliable results in all field experiments.

The first point of fundamental importance is, that before judgment can be passed on the virtues of any particular system of tapping or on the value of any particular manure or other treatment, with any real certainty as to the accuracy of the verdict, it must be known that the differences observed between the field plots differently treated, are considerably greater than a difference which might result from error involved in the execution of the experiment. In no field experiment on Rubber—with which we are more immediately concerned—has this error, in so far as we can judge, been determined, and in consequence we have "no real certainty of the degree of accuracy of the verdict pronounced as a result therefrom." It may be true this apparently drastic criticism does not seem to hold in cases where resulting differences are of such great magnitude as for example those obtained from rubber subjected to such widely varying treatment as every day, alternate month or alternate week tapping, for it is highly probable that the initial plot error and the errors involved in the execution of the experiments would not be so great as to counteract differences of such magnitude, but even here the extent to which this holds is a matter of conjecture, in fact, we are still in the dark as to the relative values of any system of tapping in the sense of being able to pronounce a verdict of such nature as to say, that this system is better than that by a certain amount. But in passing it may be well to mention that although the method suggested hereunder may give reliable results, it will not once and for all clear up the question of tapping, for in this we are meeting with a dual problem, that which deals with young rubber from the point of view of immediate return therefrom, and that which deals with it as representing capital value to be exploited at maximum profit over maximum time. Experiments will have to go on over a long period,—new experiments will be devised as our knowledge grows—and this makes it all the more urgent that the initial work should be as sound as it can possibly be made.

Now in conducting any field experiment it is necessary at the outset to determine the normal variation which is present in the material with which we are working. In order to illustrate clearly what this normal variation is and how its value is determined, it is necessary to give actual numerical examples, and since we are entirely without data on rubber, and so far as we know none are available, the figures obtained for rice are used. The figures given

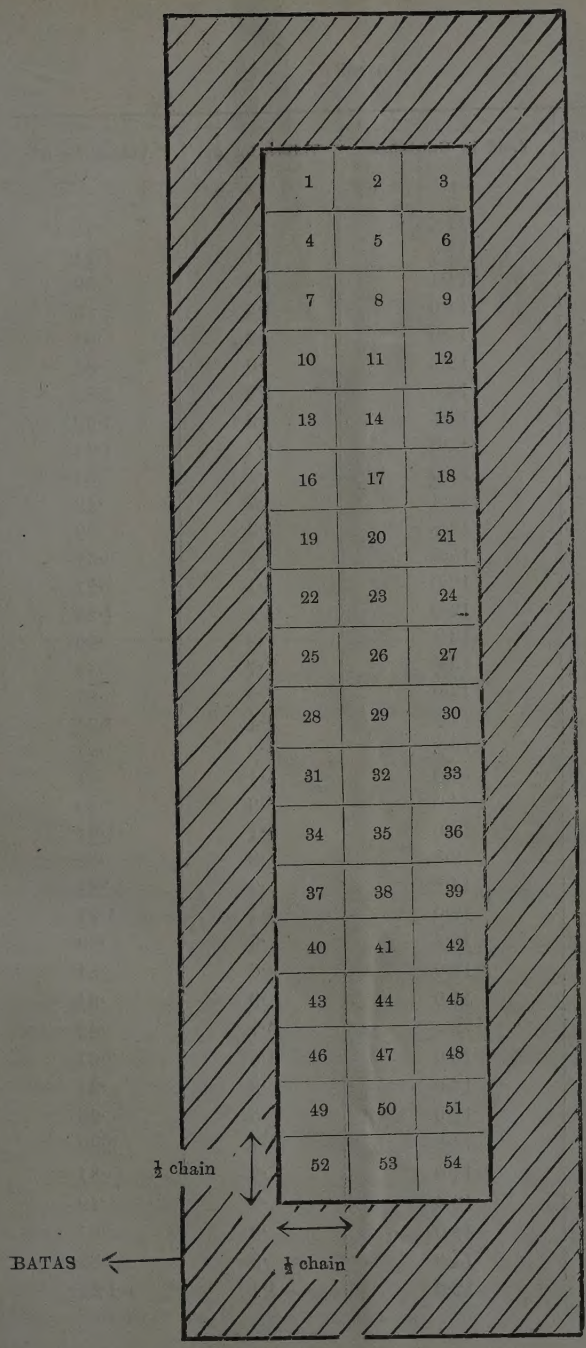

Diagram shewing the disposition of the $54 - \frac{1}{40}$ acre plots. The shaded area shews the standing rice of the field.

Number of Plot.	Yield in Gantangs	Values for d.	Values for d^2
1	13·6	·5	·25
2	12·0	1·1	1·21
3	11·4	1·7	2·89
4	14·6	1·5	2·25
5	14·0	·9	·81
6	12·2	·9	·81
7	14·8	1·7	2·89
8	14·4	1·3	1·69
9	12·0	1·1	1·21
10	13·0	·1	·01
11	12·4	·7	·49
12	12·8	·3	·09
13	15·0	1·9	3·61
14	12·0	1·1	1·21
15	12·0	1·1	1·21
16	13·4	·3	·09
17	13·8	·7	·49
18	14·0	·9	·81
19	14·2	1·1	1·21
20	12·2	·9	·81
21	13·0	·1	·01
22	14·0	·9	·49
23	12·0	1·1	1·21
24	12·8	·3	·09
25	14·0	·9	·81
26	12·0	1·1	1·21
27	13·4	·3	·09
28	14·0	·9	·81
29	14·0	·9	·81
30	12·4	·7	·49
31	15·0	1·9	3·61
32	14·0	·9	·81
33	12·6	·5	·25
34	14·8	1·7	2·89
35	14·0	·9	·81
36	12·4	·7	·49
37	14·0	·9	·81
38	14·0	·9	·81
39	12·0	1·1	1·21

Number of Plot.	Yield in Gantangs	Values for d.	Values for d^2
40	14·4	1·3	1·69
41	13·6	·5	·25
42	12·4	·7	·49
43	12·6	·5	·25
44	13·0	·1	·01
45	12·0	1·1	1·21
46	12·2	·9	·81
47	14·0	·9	·81
48	12·8	·3	·09
49	11·6	1·5	2·25
50	12·0	1·1	1·21
51	11·8	1·3	1·69
52	12·4	·7	·49
53	14·0	·9	·81
54	12·4	·7	·49

TOTAL = 709·4 gantangs Σ d^2 = 54·62

MEAN OR AVERAGE = 13·1 gantangs

PROBABLE ERROR = $\cdot 67 \sqrt{\frac{54\cdot 62}{53}}$

= $\pm \cdot 67$

= $\pm 5\cdot 1\%$

in the accompanying table, were obtained this harvest—in point of fact not for the purpose which we now use them, but to get a rough idea of the suitability of certain land for variety testing in the ensuing year,—an area of standing rice all of the same variety being measured off accurately to the dimensions specified, and the weights of unhusked rice obtained therefrom. The disposition of the plots both with respect to themselves and with respect to the surrounding rice is indicated in the figure. The crop was extremely regular as judged before cutting and it had not been subjected to any attack of borer or any devastation by rats or birds.

Now from these figures it will be seen that each value varies from the average value or mean. From these differences there can be computed a constant quantity such that taking any single plot-result at random, the chances are even for or against, that this result will vary from the average by the amount of that constant. That constant is the index of normal variation, and is known as

the Probable Error; it is a measure of the reliability of the result of any plot, and for each of the 54 plots in question is of the value as calculated from the formula,

$$\text{Probable Error} = \cdot 67 \sqrt{\frac{\sum d^2}{n(n-1)}}$$

$$= \cdot 67 \sqrt{\frac{56 \cdot 62}{54-1}} = \pm \cdot 67 \text{ (approx.)}$$

or expressed as a % of the Mean = $\pm$ 5·1%, where $\sum d^2$ = the sum of the squares of the differences of each result from the Mean, and n = the number of results.

Now by combining contiguous plots, the size of the unit plot may be increased. The disposition of the original small plots will limit the manner in which there may be combined to produce larger comparable areas, combinations of proximate plots only being permissible. In the case in point, in combining proximate plots in twos, (1 and 4, 2 and 5 etc.) the Probable Error of a double-sized plot is found to be $\pm$ 4·4%.

Now from our definition of Probable Error it will be seen in the light of this result, that increasing the size of the plot leads to greater accuracy of any single result. But this increase in the size of the plot cannot be carried on indefinitely for, though the errors due to variation in the population of plants grown on the land and to inaccuracies in weighing etc. are reduced by this increase, there will come a time when this reduction becomes balanced by the increase in systematic errors due to soil variation; these latter will obviously be larger as the area becomes more extensive. It may be that padi soils—and it almost certainly is the case in the soils of the area whence these results were collected—do not generally give that variety of conditions that obtain on other lands, as for example on areas where wheat is grown. It was found for this latter crop that practically no additional accuracy was obtained by increasing the size of the plot above one eightieth of an acre, in fact in field experiments in England it was found that the Probable Error was 5% of the crop, and that this figure was independent of the size of the plot employed so long as this size was one eightieth of an acre or larger. There is then a minimum size of plot which will give the same accuracy as one of larger size. Now in our particular instance, in the 54 rice plots, we have an insufficient area on which to obtain, by plot combination, a sufficiently large number of large plots, on which to calculate the size which gives the minimum probable error, but this from the point of view of the object of this paper is of no importance.

Having found the Probable Error, minimum or otherwise, we can obtain still greater accuracy by taking advantage of the fact that the Probable Error of the average of a number of results is equal to the Probable Error of one result divided by the square root of n results

$$= \frac{\text{Probable Error of one result}}{\sqrt{\text{n}}}, \text{ and for the averaged result of 54 plots the Probable Error} = \pm \frac{5.1\%.}{\sqrt{54}}$$

Similarly for 27 plots of double the size the Probable Error of the average $= \pm \frac{4.4\%.}{\sqrt{27}}$

Thus we see that duplication as distinct from massing, provides a supplementary means of obtaining still more accuracy, and it is to this method we resort when we find that an increase in the size of the plots fails further to reduce the Probable Error.

Now in comparing two results each liable to the same probable error, the difference between these two results will be liable to a still greater error, in fact the probable error of the difference of two such results is $\sqrt{2}$ times the Probable Error of one result, and thus, the Probable Error of the difference between any 2 plots of the 27 rice-plots made by combining the initial blocks in contiguous pairs, will be $\pm 4{\cdot}4 \times \sqrt{2}\%$.

Now supposing we were using two of the 27 plots for testing the value of some particular manure; from our definition of Probable Error it follows that a difference of about the same magnitude as the Probable Error is just as likely as not to be due to Normal Variation, and hence such a difference cannot be taken to be significant in representing the effect of the altered treatment. But if this difference now obtained is more than the Probable Error, the chances that this is due to Normal Variation rapidly decrease, the more rapidly as the difference increases.

The following table shows the actual odds against the various differences, as measured in terms of the Probable Error of single plots, being due to Normal Variation:—

Difference between two results divided by the Probable error of one result	Odds against such being due to Normal Variation.	
	Odds in one direction.	Odds in both directions.
1·41	3 : 1	1 : 1
1·76	4 : 1	3 : 2
2·03	5 : 1	2 : 1
2·23	6 : 1	5 : 2
2·41	7 : 1	3 : 1
2·55	8 : 1	7 : 2
2·68	9 : 1	4 : 1
2·83	10 : 1	9 : 2
3·50	20 : 1	10 : 1
3·81	30 : 1	15 : 1
4·07	40 : 1	19 : 1
4·24	44 : 1	22 : 1

The odds in one direction would be used to detect increases due to manurial treatment etc. where an increase would be the only quantity looked for, and the odds in both directions would be applied to the detection of yield differences between various varieties etc. From this table it will be seen that if we obtain a 10% increase in an experiment with two of the 27 plots using one as a control, the odds on this being due to manure will be those corresponding in column 2 to a quotient in column 1 of the fraction $\frac{10}{4\,4}$ *i.e.* to 2·27 which shows 6 : 1 to be the odds.

It cannot be taken that these odds will ensure practical certainty that this difference is due to manuring. It is generally assumed that odds of 30 : 1 amount to practical certainty. Reference to the table shews that 30 : 1 odds in detecting a difference in one direction require that the difference shall be 3·8 times the Probable Error.

Thus for a 10% detection we have, $10\% = 3{\cdot}8 \times$ Probable Error

$$i.e.\ \text{P. E.}\ \frac{10}{3.8}\% = 2{\cdot}6\%.$$

Now as stated above the probable error of any single result can be decreased by increasing the number of plots and taking the average—that is by duplication, which average has of itself a

Probable Error of :— $\frac{\text{Probable Error of one result}}{\sqrt{n}}$ where n is the number of duplications. Thus in evaluating n for the rice plots in the detection of a 10% difference with odds of 30 : 1 we have :—

$$\frac{\pm \ 4{\cdot}4}{\sqrt{n}} = \frac{10}{3{\cdot}8}$$

$$\therefore \ n = 2{\cdot}89$$

Thus on rice with a probable error of $\pm$ 4·4%, on wishing to detect a difference of 10% it is necessary to duplicate 3 times. Similarly a calculation could be made for a detection of 5% or 15%, and it will be noted that a reduction can be made in the number of duplications necessary, if it is assumed that odds of less than 30 : 1 amount to certainty, but it is advisable to take these odds as standard.

The following table illustrates how the number of plots necessary to detect varying percentage differences varies for 30 : 1 certainty with a 5% probable error in a single plot.

Precision desired in percentage difference between yields.	Probable Error must be reduced to below * per cent.	This requires the number of plots given below, any fraction being counted as the next higher whole number.
20	$\frac{20}{3{\cdot}8}$	1
15	$\frac{15}{3{\cdot}8}$	2
10	$\frac{10}{3{\cdot}8}$	4
8	$\frac{8}{3{\cdot}8}$	6
6	$\frac{6}{3{\cdot}8}$	10
4	$\frac{4}{3{\cdot}8}$	23
2	$\frac{2}{3{\cdot}8}$	91

So much for the method. Now it will be seen that before this method can be applied to rubber, it is necessary that we obtain preliminary data of like nature to that obtained for rice. These latter be it noted are in no way complete for that crop.

The whole question of duplication necessary in field experiments on rubber depends on the extent to which it is possible to reduce to Probable Error by increasing the size of the plot. Thus of example, supposing the Probable Error can be reduced to 2%, then for a detection of anything over 8% no duplication is necessary. On the other hand should this Probable Error be anywhere in the neighbourhood of 10% then a duplication of 15-20 times is necessary. At present we are absolutely in the dark as to the magnitude of the Probable Error in rubber and we have been unable to obtain any figures on which to calculate it. That it can reach a considerable magnitude in a tree crop is shewn by the following figures for coconuts plucked from 8 blocks each of two acres of old trees over a period of six months.

Plot Number.	Number of Nuts.
1	4408
2	3969
3	4714
4	3532
5	3833
6	3840
7	4019
8	3918

Av. = 3991
P. E. = $\pm$ 231
= $\pm$ 6%.

and the P. E. of the difference of any two results = $\pm 6 \times \sqrt{2}\%$ = $\pm$ 8·5%.

Now from table I we see that the difference between two results divided by the Probable Error a single result gives for odds of 30 : 1 a quotient of 3·8—*i.e.* $\frac{\text{difference between two results}}{6} = 3{\cdot}8$

Hence the increase due to any particular treatment in an experiment with two single plots could only be significant if the difference obtained from the results of these two plots *exceeded* 3·8 × 6·0, that is 22·8%.

Also from above we have, for a detection of a 16% difference with 30 : 1 odds, $\frac{\pm 6.0}{\sqrt{n}} = \frac{16}{3.8}$ *i.e.* $16\sqrt{n} = \pm 6{\cdot}0 \times 3{\cdot}8$ whence n = 1·96.

Thus if the difference to be detected amounted to 16% only, then it would be necessary to use 4 plots, 2 manured and 2 controls.

Thus, the first requirement in experimenting with rubber whether it be tapping experimentation or manurial work, is the obtaining of reliable records of a large number of small plots under similar conditions of treatment. Yields from these plots should be taken for a period of at least a year and longer if possible, and the results could then be used for computing the Probable Error and for fixing the minimum size of the plot and upon these results future experiments could be based.

In conclusion the writers wish to acknowledge their indebtedness to the Agricultural Instructor, Krian for the rice figures used in this article.

A Die-back disease on Hibiscus:

By A. Sharples.

Many of the numerous species of Hibiscus grown for ornamental purposes in the F. M. S. are attacked by a fungus which causes a dying back of the shoots. This "die-back" is seen especially well in hedges of H. Rosa sinensis, which are cut back periodically. The shoots blacken and start dying back from the tips, the leaves shrivel and fall, and an ugly looking bare mass of dead branches is the result. The die-back may proceed so far as to kill the bush; in many places round Ipoh and Kuala Lumpur, thick luxuriant edges have been completely killed out.

Work upon this disease was commenced in 1912 and successful inoculations were obtained. However these happened so irregularly and unexpectedly that it was obvious other factors were influencing the results, so the work was not published. There was no opportunity to continue the work till 1915, when the inoculation experiments carried out finally settled the incidence of the disease.

For the purposes of this short article it is unnecessary to trace back the investigation to the beginning. The results obtained during 1915 are the most important and the work undertaken about this period only will be mentioned.

Attempts to isolate the causal fungus resulted in two fungi being obtained in pure culture (a) Colletotrichum sp. (b) Fusarium sp. They were isolated from a dying branch which was cut to expose the junction of healthy and diseased tissues. Small pieces of wood from the junction were placed in damp chambers on Potato agar, and hyphae soon began to grow out. From the damp chambers transfers to test-tubes were made and the fungi mentioned above were obtained.

Experiments with the Colletotrichum sp. were first conducted as this fungus was found to be responsible for a "Spotting" which occasionally appears on unhealthy leaves. Numerous inoculations were made on plants in the Laboratory but none were successful.

Inoculation experiments with the Fusarium sp. were next carried out, both on wounded and unwounded plants. The wounded plants were inoculated by placing small pieces of mycelium in T shaped cuts of varying depths, some penetrating well into the wood.

Successful inoculations were obtained but as in the previous work, the results were so contradictory that no definite conclusions could be drawn as to whether this fungus was the cause of the disease or not.

The fact that hedge plants suffer most led to the idea that the periodical pruning may be of moment in the prevalence of the disease. This was tested by pruning plants in the Laboratory and placing small pieces of mycelium on the cut ends of the green shoots. The results were immediate. Twenty four hours after inoculation the green tip was blackened for $\frac{1}{2}$" below the cut end, and this blackening descended through the shoot at the rate of about $\frac{1}{2}$" to 1" per day. Fifty to sixty such experiments were carried out always with the same result. In some of the inoculated plants only two or three shoots were nipped off and mycelium placed on the ends; every time the blackening was obvious 24 hours afterwards. Control plants treated in this manner always remained healthy but if all the shoots were pruned the "die-back" often entered the controls from outside sources.

The inoculation experiments prove undoubtedly that this *Fusarium* sp. is the cause of the "die-back" on *Hibiscus* sp., and that the predisposing cause is the exposure of the cut ends of shoots brought about by pruning or in other ways. Therefore the treatment consists in protecting the cut ends of branches for some time after pruning; in case of single plants, all breakages etc. will have to be attended to.

If pruning is to be undertaken, the bushes should be sprayed immediately after cutting with Bordeaux mixture. (See Agricultural Bull. Vol. I, No. 2) of a strength 12: 8: 100: This will protect the cut ends of the shoots preventing the entry of the fungus by this path. Hedges already attacked should have the dead and dying branches removed completely and then sprayed as above. Spraying after pruning should be successful in preventing the spread of the disease.

The Effect of Vacuum Drying Crepe Rubber

By B. J. Eaton.

In order to test thoroughly the effect, if any, of vacuum drying on crepe rubber, both on the rate of vulcanisation and on the physical quality of the vulcanised rubber, a series of samples were prepared on two different estates. In each case the experiment was repeated on eight different days, the following samples being prepared in each series on each day:—

A. Thin crepe dried at ordinary temperature in drying room.

B. Another portion of the above dried in Passburg vacuum drier.

C. A portion of B remachined after removal from vacuum drier, as is always done on estates when preparing vacuum dried rubber for the market.

Altogether therefore forty-eight samples were vulcanised and tested, *i.e.*, twenty-four from each estate.

No exact details were obtained with regard to the dilution of the latex nor amount of acetic acid used as coagulant since all the samples from each estate are strictly comparable, in this respect, for any one series prepared on a particular day, *i.e.* samples A, B and C on each day are from the same latex coagulated in bulk.

The vulcanisation results were as follows, the conditions of vulcanisation being those usually adopted by us, viz. a mixing of 10 parts of sulphur with 90 parts of rubber vulcanised for varying periods at 140°C:—

Ref. No.	Optimum time of cure from optimum curve. Hours.	Optimum time of cure from maximum product. Hours.	Breaking Load. (Kgs. per sq. mm) (a)	Elongation at break (Orig. length = 100) (b)	Product (axb)
201 S 1A.	3¼	3½	1.41	974	1374
„ B.	3¼	3½-3¾	1.21	962	1164
„ C.	3¼	3½-3¾	1.10	959	1054
201 S 2A.	3¼	3¼-3½	1.36	980	1332
„ B.	3¼	3¼-3½	1.46	985	1438
„ C.	3¼	3¼-3½	1.25	972	1215
201 S 3A.	3¼	3½	1.25	969	1211
„ B.	3¼	3½	1.18	959	1122
„ C.	3¼	3½	1.29	969	1250

No.	Optimum time of cure from optimum curve. Hours.	Optimum time of cure from maximum product. Hours.	Breaking Load. (Kgs. per sq. mm) (a)	Elongation at break (Orig. length = 100) (b)	Product. (axb)
201 S 4A.	3¼	3½	1.42	964	1368
„ B.	3	3½	1.33	952	1266
„ C.	3	3½	1.29	951	1226
201 S 5A.	3½	3½	1.20	966	1159
„ B.	3½	3½	1.19	913	1145
„ C.	3½	3½	1.26	983	1238
201 S 6A.	3¼	3½	1.32	950	1254
„ B.	3¼	3½	1.20	955	1146
„ C.	3¼	3½	1.23	960	1180
201 S 7A.	3	3¼	1.36	962	1308
„ B.	3	3¼	1.27	960	1219
„ C.	3	3¼	1.31	973	1274
201 S 8A.	3¼	3¼	1.28	972	1244
„ B.	3¼	3¼	1.12	968	1084
„ C.	3¼	3¼	1.21	958	1159
205 S 1A.	3¼	3¼	1.29	972	1253
„ B.	3¼	3¼	1.26	960	1209
„ C.	3¼	3¼	1.19	959	1141
205 S 2A.	3	3½	1.39	940	1306
„ B.	3	3½	1.40	936	1310
„ C.	3	3½	1.40	935	1309
205 S 3A.	3	3½	1.35	934	1260
„ B.	2¾	3¼	1.42	948	1346
„ C.	3	3¼	1.43	959	1371
205 S 4A.	2¾	3	1.41	951	1340
„ B.	2¾	3	1.42	955	1356
„ C.	3	3¼	1.30	944	1227
205 S 5A.	3¼	3¼	1.19	956	1137
„ B.	2¾	3	1.43	953	1362
„ C.	3	3 -3¼	1.36	955	1298
205 S 6A.	3	3¼	1.23	965	1186
„ B.	3	3¼	1.35	965	1302
„ C.	3	3 -3¼	1.41	954	1345
205 S 7A.	3¼	3¼	1.19	976	1161
„ B.	3	3¼	1.26	955	1203
„ C.	3¼	3¼	1.11	965	1079
205 S 8A.	3¼	3¼-3½	1.21	940	1137
„ B.	3¼	3¼-3½	1.29	943	1216
„ C.	3¼	3¼-3½	1.06	954	1011

It will be seen from the results given above that all the samples have a very uniform rate of cure, the difference between the air dried and vacuum dried samples on any one day being always within ¼ hour with the exception of one series where the difference is slightly greater. For the whole 48 samples, the rate of cure, especially as determined by the load-stretch curves, is very constant at about 3 to 3½ hours and generally between 3 and 3¼ hours.

The rate of cure, as is always the case with thin crepes machined on the day of or after coagulation, is slow, being the extreme limit for plantation Para rubber coagulated by acetic acid. The uniformity in rate of cure was anticipated, since thin crepe during air-drying undergoes practically no change, the substances in the latex or serum to which variability in rate of cure is due, being practically reduced to a minimum.

It will also be observed that the physical properties of the vulcanised rubber undergo no deterioration by vacuum drying. A few of the samples give tensile properties equal to the best grades of plantation Para rubber, but the majority of the samples, like practically all estate samples of thin pale crepe, are inferior in quality to plantation sheet, smoked or unsmoked. The tensile strength etc. of thin pale crepe compared with sheet, is almost always about 20 to 25 per cent below that of sheet rubbers. This is attributed to the almost complete removal of the substances essential to vulcanisation, since the strength of such rubbers can be recovered by the replacement of these substances. Generally speaking it is extremely doubtful whether the inferiority of thin crepe rubber is due to the macerating and tearing action per se on the crepeing machines.

Although no experiments have yet been carried out, it is practically certain that, if "slab" rubber allowed to mature for six days, were subsequently creped and then vacuum dried, the rapidity of cure and the tensile strength would be equal to the best qualities of air dried crepe prepared from slab.

Vulcanisation Tests for Estates.

As a number of Estate Managers do not appear to be aware that samples of rubber may be sent to the Agricultural Department for examination this note is inserted to state that the Agricultural Chemist is prepared to test and report on samples sent from any estate in the Malay Peninsula. Samples should be addressed to the Director of Agriculture, Kuala Lumpur, and should weigh at least 1¼-1½ lbs.

The following information should be sent with each sample.

(*a*) Date of coagulation.

(*b*) Date of machining.

(*c*) Period of smoking in the case of smoked rubbers.

(*d*) Amount of latex from which the sample was made, or in the case of crepe or pieces from long sheets coagulated in tanks or troughs, the amount of dry rubber obtained and the volume of latex used for this quantity. If this information is given, the Agricultural Chemist will know the rubber content of the latex used and will be in a better position to advise in connection with samples which are inferior.

(*e*) Nature of coagulant used, and the amount and strength for any particular volume of latex or amount of dry rubber.

(*f*) Any details re special treatment of sample, such as method of smoking, drying etc.

B. J. E.

Departmental Notes.

1. Mr. A. Sharples, A.R.C.S., D.I C., 1st Assistant Mycologist has been appointed Mycologist with effect from January 10th, 1916.
2. Mr. J. Lambourne, Superintendent Government plantation has been granted long leave with effect from 29th April, 1916.
3. Reprints of Bulletin No. 2: "Root Diseases of Hevea braziliensis, the Para Rubber Tree": by W. J. Gallagher; Bulletin No. 3. "Observations on Termes Gestroi as affecting the Para Rubber Tree, and methods to be employed against its Ravages": by H. C. Pratt; Bulletin No. 5. "The Extermination of Rats in Rice-Fields": by W. J. Gallagher; Bulletin No. 6. "A Preliminary note on a Branch and Stem Disease of Hevea Braziliensis": by W. J. Gallagher; and Bulletin No. 10. "A Lecture on the Para Rubber Tree": by W. J. Gallagher can now be obtained from the Department.

Comparative Returns of Imports, F. M. S. during the Fourth Quarter 1915 and 1914.

Articles	How counted.	Selangor.		Perak.		Negri Sembilan.		Pahang.		1915 Total.		1914 Total.	
		Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
			$		$		$		$		$		$
Coconuts	Pikuls	...	...	...	418	...	9	...	...	...	427	...	46
Copra	,,	...	...	...	...	...	...	...	...	...	...	226½	1,807
Coffee	,,	18½	514	311	9,658	67	1,900	55	1,707	451½	13,779	178½	4,891
Padi	,,	5,343	15,214	6,384	17,418	541½	1,602	526	1,590	12,794½	35,824	17,532½	49,713
Rice	,,	332,343	1,658,947	363,358	1,794,663	86,058	423,887	26,851	143,905	808,610	4,021,402	763,452	3,936,426
Pepper	,,	109	2,542	50	1,628	29	731	...	...	188	4,901	177	4,489
Sugar	,,	13,788$\frac{11}{20}$	121,842	32,323$\frac{1}{10}$	292,901	4,387	37,024	1,154	10,984	51,652$\frac{13}{20}$	462,751	50,591	360,055
Tapioca	,,	585¼	2,587	1,690	18,137	144½	1,126	1	7	2,420¾	21,857	1,677	17,270
Gambier	,,	30	502	98	1,939	17	156	26	377	171	2,975	216¼	3,018

Comparative Returns of Exports, F. M. S. during the Fourth Quarter 1915 and 1914.

Articles	How counted.	Selangor.		Perak.		Negri Sembilan.		Pahang.		1915 Total.		1914 Total	
		Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
			$		$		$		$		$		$
Coconuts	Pikuls	...	...	...	45	...	41	...	62	...	148	...	413
Copra	,,	11,065½	82,028	40,611	284,326	295	2,063	416	2,912	52,387½	371,329	73,218¼	566,119
Coffee	,,	1,002⅘	31,729	78½	1,404	...	...	...	..	1,081$\frac{3}{10}$	33,133	2,147	69,571
Padi	,,	...	...	589	1,580	...	...	...	...	589	1,580	7,286	19,291
Rice	,,	...	...	32,908	165,127	...	...	...	...	32,908	165,127	15,983	69,130
Pepper	,,	...	...	...	...	2½	41	23	521	25½	562	10	122
Sugar	,,	...	722	3	144	...	...	...	...	3	866	13½	142
Tapioca	,,	...	...	1,143	4,988	3,658	19,805	6,581	32,905	11,382	57,698	11,966	63,676
Gambier	,,	...	...	...	...	3,319	43,667	...	...	3,319	43,667	2,201	17,209

Export Tables for 1915.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
Johore	...	...	.	...	...	...	727.66	769.27	836.08	905.13	954.12	1,006 78	5,199.04
Kelantan	34.26	30.04	48.94	37 37	38.78	38.98	50 74	50.01	58.41	48.23	46.15	52.86	534 77
Kedah	139.74	123.16	148.76	137.48	132.01	116.86	149.90	151.32	181.90	232.99	241.62	266.35	2,022.09
Perlis	...	...	...	...	...	.06	.24	.04	.37	.31	.37	.50	1.89
B. N. Borneo	...	...	...	...	...	...	...	91.09	90.53	121.45	101.59	151.83	556.49
Brunei	1.08	.92	2.07	.60	3.63	1.00	.73	3.65	1.14	4.79	5.85	9 33	34.79

Exports of Rubber From British Malaya, (other than the F. M. S.)

State.	Month.	Quantity.
Johore	February 1916	lbs. 2,349,467
Kelantan	February 1916	lbs. 139,168
Kedah	February 1916	lbs. 610,901½
Perlis	February 1916	lbs. 477½
British North Borneo	February 1916	lbs. 296,318
Brunei	...	...

FEDERATED MALAY STATES.

Comparative Statement of Cultivated Rubber Exported, with Value and Duty Collected Thereon, During the Years 1916 and 1915.

Destination.	Exported during March, 1916.	Previously.	Total export during the year.	Export during similar period of previous year.	Increase.	Decrease.	Value of rubber exported, 1916.	Duty collected, 1916, to date.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	$	$ c.
Straits Settlements ...	3,291.54	6,903.81	10,195.35	6,619.38	3,575 97	...	31,242,237	
United Kingdom ...	1,048.60	2,482.88	3,531.48	3,407.26	124.22	...	10,762,313	
Continent of Europe...	...	...	...	1.00	...	1.00	Nil	
Ceylon	60.77	168.28	229.05	179.55	49.50	...	687,256	
Other Countries ...	28.33	123 09	151.42	95.07	56.35	...	452,264	
Total ...	4,429.24	9,678.06	14,107.30	10,302.26	3,806.04	1.00	43,144,707	1,117,201.40

KUALA LUMPUR,
6th April, 1916.

E. BURNSIDE,
Acting Commissioner, Trade and Customs, F.M.S.

Abstract of Meteorological Readings in the various Districts of Malaya for the month of February, 1916.

DISTRICT.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	TEMPERATURE.				HYGROMETER.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Kota Bahru ...	...	142.8	79.0	88.34	68.93	19.41	73.6	.728	69.8	73.	...	...	...
Pahang, Kuala Lipis ...	...	...	80.8	89.4	71.8	17.6	74.6	...	...	...	...	.92	.19
Johore, Johore Bahru ...	...	...	...	90.88	71.47	19.41	...	...	...	...	...	1.42	...
Singapore, Kandang Kerbau	29.793	164.0	83.5	89.7	72.6	17.1	77.5	.860	...	75.	...	.44	.22
Malacca, Durian Daun ...	29.797	151.8	82.	88.7	70.4	18.3	78.2	.925	...	88.	...	1.98	1.98
Negri Sembilan, Seremban	...	150.1	79.3	91.6	70.3	21.3	76.4	.844	74.6	85.2	N.W.	2.19	1.10
,, Kuala Pilah ...	...	151.0	82.3	91 3	72.1	19.2	79.6	.921	76.5	83.4	...	1.29	.52
,, Port Dickson	...	136.5	82.3	88.3	74.2	14.1	76.8	.821	73.2	71.1	...	1.02	1.00
Selangor, Kuala Lumpur ...	29.810	139.4	81.9	90.3	70.9	19.4	75.8	.766	71.2	68.	N.E.	.78	.35
,, Klang ...	...	...	81.0	87.1	72.9	14.2	75.6	...	...	...	...	1.53	1.47
,, Kuala Selangor ...	...	...	...	89.1	73.7	15.4	...	...	...	...	...	.61	.47
,, Rawang ...	...	...	...	92.9	...	...	...	...	...	...	...	3.29	1.25
Perak, Telok Anson ...	...	...	81.82	91.	67.	24.	75 95	.819	...	76.		1.58	.87
,, Ipoh ...	...	...	83.23	96.	66.	30.	75.05	.761	73.05	67.	...	2.30	1.33
,, Taiping ...	...	154.	81.78	94.	70.	24.	76.24	.831	...	77.	...	6.45	1.37
,, The Cottage ...	...	...	..	...	...	...	...	...	...	...	...	8.99	2.17
,, Parit Buntar ...	...	...	83.03	94.	65.	29.	76.77	.837	...	75.	...	.61	.49
Penang, Georgetown ...	29.797	143.7	82.4	89.4	71.5	17.9	75.7	.797	72.5	72.	E.	4.09	1.53
Kedah, Alor Star ...	...	...	...	...	...	...	...	...	...	...	...	.20	.19
Perlis, Perlis ...	...	...	...	90.48	69.89	20.59	...	...	...	...	...	.63	...